State of Maine
Department of Environmental Protection
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Edited/Adapted Field Guideline for Protecting Residents From Inhalation Exposure to Petroleum Vapors

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EDITED/ADAPTED FROM OCTOBER, 1998 ORIGINAL PREPARED BY:

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This Guideline is an edited version of the document prepared for the Maine Department of Environmental Protection (DEP) by Menzie-Cura and Associates which is dated October 1998 and titled "Guideline for Protecting Residents from Inhalation Exposure to Petroleum Vapors." The edited version varies from the original in that it is adapted to reflect existing policies of the petroleum programs within the Bureau of Remediation and Waste Management, it is updated to reflect changes since the Guideline was published, and it is edited to focus on application of the Guideline. References, derivation of action levels, definitions and development of the Guideline may be found in the original document, copies of which may be found in each of DEP's regional offices. To understand the basis for this version of the Guideline and all of the recommendations incorporated into it, it is necessary to read the original document in its entirety, including all appendices.
The original document has been approved by DEP management and reviewed by DEP's Toxicologist. DHS declined review.

TABLE OF CONTENTS

1. INTRODUCTION

Petroleum spills can adversely affect indoor air quality in homes, yet no comprehensive guidance is available to aid state agency staff in responding to this problem. The Maine Department of Environmental Protection (DEP) receives hundreds of calls each year from residents concerned about fuel oil spills, some of which create indoor air quality problems in homes. This Guideline describes DEP's approach for responding to residential indoor air quality concerns resulting from fuel oil, gasoline and kerosene releases during storage or delivery.

1.1 Background

Petroleum may affect residential indoor air quality following accidental releases from interior/exterior/underground oil heating systems as well as underground gasoline tanks and piping. Fuel oil and kerosene spills are commonly the result of storage system failures (corrosion of the copper line or tank), overfills and over-pressurization of the system, severed filters, tank rollovers due to unstable foundations, and delivery to incorrect locations. Gasoline spills usually result from corroded or improperly installed underground tanks or piping. Residential indoor air may be impacted by petroleum spilled in a residence, petroleum-contaminated groundwater migrating into a basement and volatilizing, or petroleum vapors entering a building.

1.2 Intent and Limitations of Field Guideline

DEP staff can use this Guideline to determine:

- when the risk posed by petroleum vapor warrants investigation;
- when the risk posed by petroleum vapor warrants evacuation;
- when indoor air quality monitoring is needed;
- when corrective action is needed;
- how the investigation should be conducted; and
- how indoor air quality data should be evaluated to ensure that the health of all residents is protected.

This Guideline addresses residential exposure to petroleum vapors via the inhalation route of exposure. It establishes indoor air concentration Action Levels for some petroleum constituents that are intended to guide decision-making regarding evacuation, cleanup and closure. The Action Levels are protective of human health using the best toxicological data available at this time. They were established considering only potential human health effects; therefore, petroleum odors may persist for some time after remedial measures have reduced concentrations to below these action levels.

The selected compounds of concern were chosen based upon limited data regarding volatility, toxicity and per cent composition (by weight). There is insufficient information to determine if action levels for indicator compounds will protect against adverse effects from exposure to total mixtures of petroleum vapors. To make such a determination will require data on the product composition and total petroleum hydrocarbon concentration of vapor mixtures that result from spills. Absent such data, it is only possible to conclude that actions taken in accordance with the guidelines will help limit health risks posed by exposure to fuel vapors. However, determination of no adverse effects from exposure to total mixtures will not be possible.

Currently available sampling and analytical tools to assess air quality further limit this guidance. Hence it is not applicable to identifying actions that may be required over periods of less than a couple days (i.e., this guidance will not help with decisions that are required within a time frame that is shorter than what is needed for sampling and analysis).

This guidance is not intended to address and protect against potentially explosive conditions associated with petroleum vapors. Please refer to DEP's Technical Services Leaking Underground Storage Tank (LUST) Procedural Guidelines, Safety section, for information regarding installing equipment in hazardous atmospheres.

Flexibility and judiciousness must be exercised when applying the guidance for several reasons:

- This issue is considered to be in draft form;
- Over time, sampling and analytical methods likely will change and improve;
- As compound and mixture toxicity data become available, the guidance and Action Levels should be reexamined; and
- Each home is different, requiring attention to site-specific influences on indoor air quality.

1.3 Organization of the Field Guideline

Section 2 provides practical instruction and information needed to implement the Guideline. Section 3 provides a health advisory on petroleum vapors that can be distributed to concerned residents. Appendix A contains updates and revisions to the Field Guideline. Appendix B contains forms to be completed in the field during the initial indoor air assesment and during all air sampling events.

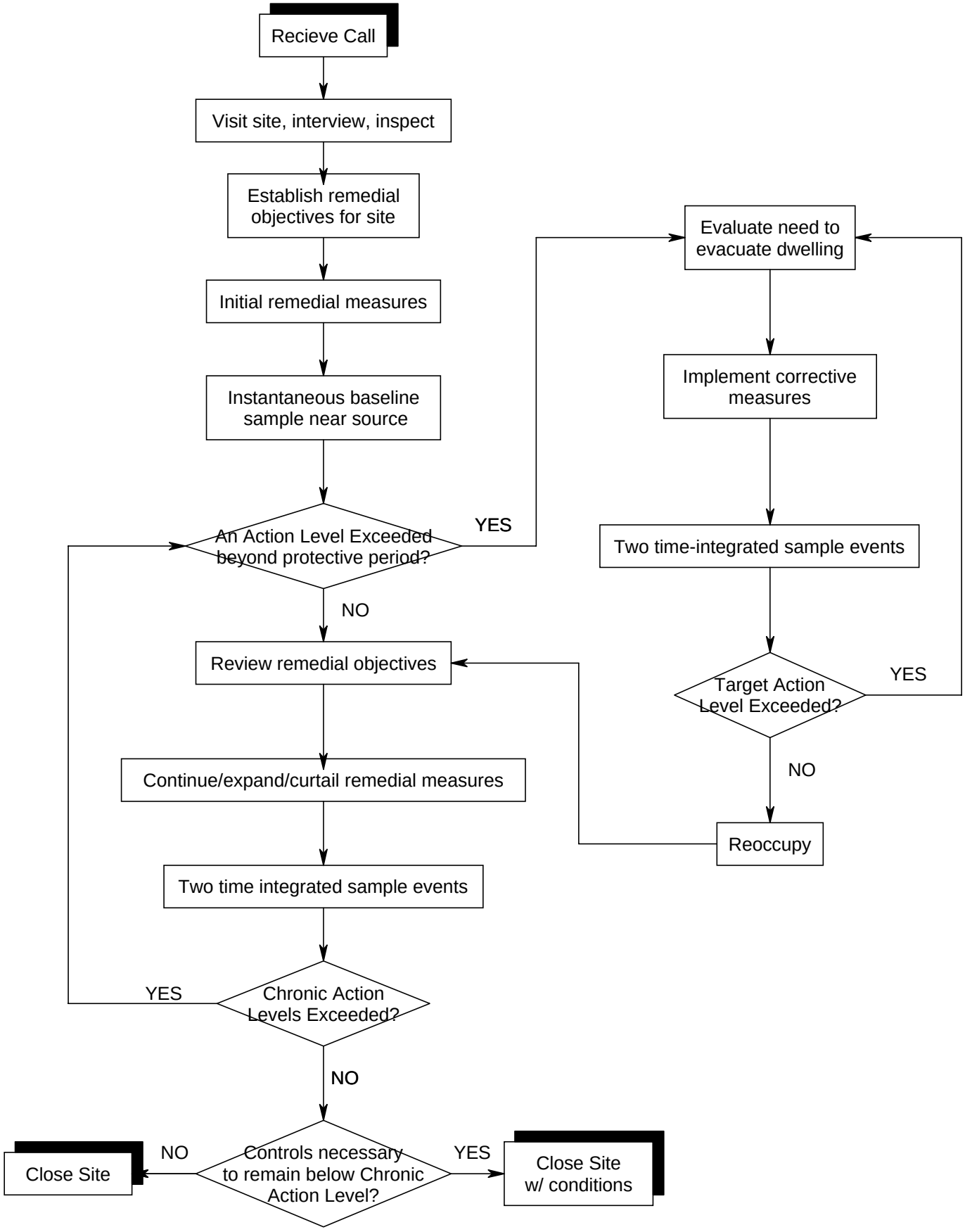
2. STEP-BY-STEP INSTRUCTION FOR IMPLEMENTING THE GUIDELINE

Sections 2.1 through 2.7 outline the steps DEP should take in investigating petroleum spills that impact residential indoor air. This approach is based on (1) information in DEP records regarding residential contamination cases that have been investigated and remediated by Maine DEP staff; (2) ideas and comments received by members of the

Residences Impacted By Petroleum Vapors Committee (RIPVC); and (3) results of research on sampling and analytical methods, petroleum compound background indoor air concentration data and available toxicity information. A flow chart which shows the procedural steps is shown in Figure 1.

FIGURE 1

INDOOR AIR INVESTIGATION, REMEDIATION AND EVALUATION PROCESS



2.1 Receive Call from Resident - Investigation Initiation

The investigation begins when a DEP staff member receives a telephone call from a Maine resident concerned about indoor air quality problems caused by a petroleum spill. The recipient of this call requests the caller's name and address as well as a description of the problem.

2.2 Conduct Interview and Visual Inspection

A member of DEP's Response Services inspects the residence to identify the petroleum spill, the type and quantity of petroleum and the extent of residential contamination. A petroleum spill may occur inside or outside of the residence. During this inspection, the DEP invesigator will first determine whether the petroleum spill is affecting or is likely to affect indoor air quality. Use the "Residential Investigation Data Form" to describe the petroleum spill, the extent of residential contamination, any health effects, and general information about the residence and its occupants.

If the petroleum spill is or has the potential to affect indoor air quality, DEP should;

- If applicable, advise residents about insurance and or Third Party Damage claim programs;
- Provide residents with DEP's "Health Advisory on Indoor Petroleum Vapors;"
- Complete all parts of the "Residential Investigation Data Form;" (Appendix B);
- Advise residents to leave their home if they are experiencing discomfort or health effects associated with the petroleum. This advice is provided prior to obtaining any indoor air sampling results.
- Conduct appropriate investigation/corrective action as soon as possible. The goal of corrective action is to reduce the level of petroleum vapors in the house as quickly as possible. DEP staff will rely on PID samplers to locate source areas and to guide cleanup efforts. A hydrogeological investigation may be necessary to remove and/or control the source of the petroleum vapors. The home should be ventilated to the greatest extent possible during corrective action to speed reduction of indoor petroleum vapor concentrations. Refer to DEP Technical Services LUST Procedural Guidelines, Indoor Vapors and Explosive Hazards section, for vapor reduction techniques.
- Request assistance from Technical Services to conduct an indoor air assesment.

2.3 Conduct Indoor Air Assessment

An indoor air assesment is recommended to; decide whether evacuation is necessary, assist in quantifying the risk that the petroleum vapors pose to the residents, determine the need for and scope of corrective actions, determine when closure is appropriate.

Two sample collection procedures, which use the same equipment, are available to assist in immediate and longer term decision making. *Time integrated samples* are generally favored

in that they provide a more representative sample of the exposure conditions than the instantaneous samples. *Instantaneous samples* are suited for urgent needs such as determining whether evacuation is appropriate or sample collection must be quick in order to minimize interference with planned or ongoing remediation.

2.3.1 Procuring Sample Equipment

DEP offices may rent sampling equipment (SUMMA® canisters, vacuum gages, and flow controllers) from the labs listed in Table 1. Shelf life for the canister vacuum is typically one year and the vacuum gage should be used to confirm adequate vacuum prior to sampling. At sites where evacuation is a consideration, request a 24 hour results turnaround from the lab.

At sites where sampling is being conducted for the purpose of evaluating sub-chronic and chronic health affects, marking remediation progress or evaluating closure, time integrated sampling is recommended. This differs from the instantaneous sampling in that flow controllers are used to regulate the canister's air intake over a pre-determined period (24 hours is recommended).

2.3.2 Collect a Baseline Instantaneous Indoor Air Sample

Remediation takes precedence over indoor air quality sampling, and should occur as quickly as possible where there is potential of acute health effects and/or property damage due to severity of the release. If possible, DEP staff should collect an instantaneous SUMMA® sample near the petroleum spill area (most likely the basement) prior to initiating remediation in order to capture "worst case" conditions. Concentration data from this "source area" sample can be used to represent a conservative estimate of risk to assist in determining whether evacuation is necessary. If it is not practical to collect a sample prior to remediation, samples will still serve as a baseline to help DEP evaluate whether corrective measures are successful. Assuming that the source area is not located in a part of the home regularly used by residents, a second baseline sample should be collected in the main living area. This "living area" sample will provide a better estimate of the petroleum concentrations to which residents are exposed.

Each time DEP Technical Services collects an indoor air sample, the "Residential Investigation Data Form" in Appendix B must be completed. It is also recommended that the sample location be screened with a photoionization detector (PID) at the instant the sample is activated. PID results can then be correlated with laboratory results.

2.3.3 Instantaneous and Time Integrated Indoor Air Sample Collection Protocol

Pre-evacuated, passivated, stainless steel, certified clean SUMMA® canisters are recommend for sample collection. Given ideal sampling conditions, SUMMA® canisters

and solid absorbents such as Tenax™ have been shown to be nearly equivalent in terms of sensitivity and reproducibility. However, sampling conditions are nearly never ideal, and there are more potential sampling problems and interferences associated with solid absorbents than SUMMA® canisters. Sample breakthrough, blank contamination, and extraction efficiency are not concerns for sampling with SUMMA® canisters. SUMMA® canisters are very portable and easy to operate. In addition, because only a small portion of the total air sample is used for sample analysis, multiple analyses can be done for samples collected using SUMMA® canisters. Multiple analyses may be necessary for a variety of reasons including instrument failure, blank carryover, and sample confirmation. Tedlar bags are not recommended for time-integrated samples because there is greater time for contact between the sample and the bag interior during longer-term sampling, which can potentially result in sample decomposition, artifact formation, and sample loss. SUMMA® canisters are a U.S. EPA validated sampling system, and the interior of SUMMA® canisters is specially treated to prevent sample decomposition and loss.

Indoor air sample collection protocols have been developed (US EPA 1993; CARB 1992) that address variables that might effect the success of sampling. These protocols were used in formulating the protocol for indoor air sampling in Maine residences. The principal objective of indoor air sampling is to obtain a worst-case representation of conditions that provides a conservative indication of health risk. To obtain such a worst-case estimate, DEP must collect samples under conditions expected to give rise to maximum indoor air concentrations. For example, worst-case sampling conditions may include (1) times of high groundwater elevation with non-aqueous phase liquid (NAPL) and/or petroleum-contaminated water entering the home through the foundation drainage system; or (2) soil vapor intrusion in winter when use of a heating system creates a chimney effect, drawing petroleum- contaminated vapors into the house. Meteorological effects (such as a low pressure front moving in) and site/spill particulars must also be considered when attempting to collect samples representative of worst-case conditions. In keeping with collecting a sample representative of concentrations created by the oil spill, other sources of indoor air pollution should be identified and eliminated prior to collecting samples.

Attempting to capture worst-case conditions is of secondary importance to minimizing the exposure to the residents. If the residents must occupy the building and concentrations may exceed subchronic action levels, simulating worst case conditions by limiting fresh air exchanges is not recommended.

Considering the objectives of representative sample collection and protection of the residents health, the sample protocol included in Appendix B is provided as a guide to samplers and residents.

2.3.4 Laboratory Analysis of Indoor Air Samples

All samples will be analyzed for the following analytes:

Benzene
n-Hexane
n-Nonane
Ethylbenzene
Toluene
M&p-Xylenes
o-Xylene
Naphthalene
MTBE

The analytical method used by DEP must be able to identify and quantify the above indicator compounds. Both Ozone Precursor Analysis and GC/MS analysis (e.g., US EPA TO-14) have the capability of identifying and quantifying these compounds. GC/MS analysis provides a more positive identification than the Ozone Precursor Analysis (which uses a GC-FID detector) because compound fragment patterns, as well as retention times, can be used for identification. Accordingly, DEP recommends GC/MS analysis (e.g. US EPA TO-14). Performance Analytical and Air Toxics provided the following quotes (In October, 1999) for supplying SUMMA® canisters and conducting the analysis.

Table 1 – Laboratory Information

Laboratory	Performance Analytical	Air Toxics
Lab Address	2665 Park Center Dr., Suite D Simi Valley, CA 93065	180 Blue Ravine Rd., Suite B Folsom CA, 95630-4719
Lab Tele/Fax No.	(805) 526-7161/526-7270	(916) 985-1000/985-1020
Contact for Orders	Kate Aguilera	Robin Goebel
Contact Tele/Fax No.	Same as above	(732) 747-3252/747-6047
Rental of polished, stainless steel, pre-cleaned, certified, evacuated, 6 liter SUMMA® canister.	$40+ship for up to 8 months. Recommend guaging vacuum prior to use to monitor for vacuum loss	$25+ship for up to 30 days $50+ship for 60 days $200+ship for 8 months. $200 includes automatic can replacement every 30 days to protect against vacuum loss
Cleaning and certification of DEP owned, 6 liter SUMMA ® canister	$35	$35
Rental of precalibrated variable/constant differential low volume flow controller, Orifice filter, vac guage	$20+ship for 10 days $40+ship for 30 days $80+ship for 60 days	$20+ship for 10 days $20+ship for 30 days $50+ship for 60 days
GC/MS analysis for 9 compounds by EPA TO-14	$290 for 24 hour $188.50 for 3 days $145 for 10 days	$330 for 24 hour $225 for 3 days $190 for 10 days
Additional TO-14 compounds	$5 for 24 hour $3.25 for 3 days $2.50 for 10 days	$0 if on ATL List $10 for 24 hour $5 for 3 days $2 for 10 days

2.3.5 Action Levels for Evaluating Results

Evaluate the results using human health based indoor air concentration action levels in Table 2.

2.3.5.1 Human Health-Based Indoor Air Concentration Action Levels

The Action Levels are intended to protect sensitive individuals from significant health effects associated with inhalation exposures to compounds found in gasoline, kerosene, and fuel oil number 2. Sensitive individuals include pregnant women, young children, elderly people, individuals with compromised immune systems, and individuals in the general population who may be susceptible to the toxic effects of a chemical due to their genetic make-up.

The Action Levels are concentrations in air that, when exceeded in the living space, require additional sampling, remedial measures, and/or evacuation of the homes. A concentration at the acute, subchronic and chronic Action Level is protective for respective exposure durations of 14 days, 365 days, and lifetime. Action Levels are listed in Table 2.

TABLE 2
INDOOR AIR ACTION LEVELS
FOR PETROLEUM VAPORS IN RESIDENCES

Compound Name	Acute Action Levels		Subchronic Action Levels		Chronic Action Levels	
	Ppb	µg/m^3	Ppb	µg/m^3	ppb	µg/m^3
Benzene	50	160	19	60	3	10
Ethylbenzene	3,300	14,000	230	1,000	230	1,000
n-Hexane	*	*	108	400	57	200
Naphthalene	53	300	6	32	2	10
n-Nonane	*	*	1,000	5,300	100	500
Toluene	4,000	15,000	265	1,000	106	400
Xylenes	1,000	4,300	700	3,000	100	400

Notes:
* Insufficient data from which to derive an Action Level
µg/m^3 values are rounded to the nearest hundred

Three Action Levels are set for each petroleum indicator compound. The three tiers of action levels were established to coincide with the time frames associated with phases of corrective action typically undertaken in response to petroleum vapors in residences.

The ***acute action level*** corresponds with the emergency phase where evacuation of the home may be necessary, vapor controls are put into place, and readily accessible sources of petroleum are removed. The ***subchronic action level*** applies to the period where source

areas are identified, comprehensive remedial actions/engineering controls are put into place, and progress is monitored. The ***chronic action level*** is associated with the point in time that DEP is satisfied that health is adequately protected and may close their involvement.

Action Levels were established after considering possible residential background concentrations to ensure that evacuation or cleanup decisions are based solely on the petroleum spill. All of the chronic Action Levels exceed background residential concentration data (none of which was collected in Maine) with the exception of that for benzene and naphthalene. Therefore, the chronic Action Level for benzene and naphthalene is set at the background indoor air concentration estimated to be found in Maine residences. If background benzene and naphthalene data for Maine becomes available, the appropriateness of the chronic Action Levels for benzene and naphthalene can be evaluated against the health protective values discussed in Appendix A.

2.3.5.2 Evaluate Results

Conclusions from a study of air quality at 13 homes in Maine impacted by petroleum vapors during the during the winter of 1997/1998 may be helpful in evaluating results. The study was prepared by Menzie-Cura and Associates, is dated October, 1998, is entitled "Trial Period Findings", and copies are available at each of DEP's regional offices.

The evacuation decision is based upon the investigator's qualitative assessment of contamination levels, residents experiencing adverse health effects, and an action level being exceeded, in an inhabited part of the residence, for a period longer than the health protective period (24 hour exceedance of the acute Action Level, 15 to 365 day exceedance for the subchronic action level, and 1 year to a lifetime exceedance for the chronic action level).

If evacuation was deemed necessary for an exceedance of an acute or subchronic Action Level, re-occupation may be allowed if results from two post-corrective action samples are at or below the subchronic Action Level for all target compounds or the investigator is confident that the indoor air quality has improved substantially since the time the sample was collected.

DEP investigators should note that if smokers are present in the residence or if the residence is located near ambient petroleum sources, it may not be possible to attain some chronic Action Levels. It is also important to note that when all chronic action levels have been reached, petroleum odors (with no associated health risk) may persist in the living space.

It is also important to note that approaches to evaluate toxicity and risk associated with the total volatile petroleum hydrocarbon mixture as well as methods to measure mixtures in air are under development. To compensate for the uncertainty about the composition and

potential toxicity of the entire mixture, individual compounds may be evaluated collectively as described in the memo dated March 30, 2000 from Catherine Zeeman, included in Appendix A. The mixture evaluation is necessary where action levels for no individual compounds are exceeded.

2.4 Establish Objectives of Post-Corrective Action Indoor Air Sample

Objectives of the post-corrective action sampling must be clear prior to collecting the samples when considering the delicacies associated with evacuating and approving re-occupancy of an evacuated home. With clear objectives, an understanding of the interaction between the hydrogeological environment and the residential structure, and confidence in corrective measures implemented to date, sample objectives are more readily satisfied. Once re-occupancy criteria have been satisfied (at or below subchronic action levels), other objectives, such as assessing the effect of a particular corrective action or confirmation of achieving closure criteria, may be established with less rigor and urgency.

Regardless of sampling objective, post-corrective action samples should be collected in the same locations as the baseline event and using the protocol previously described.

2.5 Is More Corrective Action Needed?

If post-corrective action indoor air sampling results are greater than any Action Level, DEP Response Services and Technical Services staff should conduct additional corrective action and sampling. If post-corrective action indoor air sampling results are equal to or less than chronic Action Levels, a second round of 24-hour time-integrated indoor air samples must be collected to confirm the concentrations are stable. These samples should be collected at times and locations that will provide an indication of "worst-case" potential exposure conditions. DEP investigators should use the sampling protocol and their own judgment based on site-specific factors to ensure that the two samples represent likely worst-case exposure conditions.

These samples should be collected in areas of the home with the highest potential exposure that are likely to be used by residents. While residents may be able to avoid use of their basement during corrective action when petroleum constituent indoor air concentrations may be elevated, in the long run, residents need to be assured that it is safe to spend time in their basements. If both time-integrated samples are collected at different times near the source area (usually in the basement), results will provide a conservative estimate of exposure conditions in the main living area.

2.6 Site Closure: All Investigation and Corrective Action Objectives Satisfied

Before any residential investigation may be closed, two rounds of time-integrated indoor air samples must be collected and concentrations may not exceed chronic Action Levels.

Given the potential temporal variation in indoor air quality, this requirement ensures that investigations continue until indoor air concentrations of indicator compounds consistently do not exceed chronic Action Levels. For closure, it is desired to achieve concentrations in indoor air at or below chronic action levels without controls in place (such as a vapor barrier or radon fan operating). Achieving closure in this manner (without assistance) must be weighed against potential time and monetary savings realized by closing with controls in place.

If DEP finds that it is infeasible to attain Action Levels , DEP investigators should consult with the Maine Department of Human Services (DHS) to evaluate site-specific factors that may be preventing attainment of these indoor air quality goals. There are two likely reasons that Action Levels may not be attainable:

- The Action Levels consider available residential background concentration data for indicator compounds, but these data are scarce and not specific to Maine residences; and

- The Action Levels were established to protect human health, but they do not consider the practical limitations of corrective action measures available to DEP.

2.7 Documentation of the Residential Response Action and Remediation

A file must be maintained for each residential investigation. Each time the residence is visited by DEP personnel, the visit as well as all activities during the visit must be documented. A final report should be prepared that, at a minimum, includes the following information:

- Residential Investigation Data Form (Appendix B)
- Field Notes
- Field Sampling Equipment and Methods
- Analytical Methods
- Laboratory Chain-of-Custody forms
- All indoor air concentration data for indicator compounds
- All quality control sample results, including duplicates
- Photographs and sketches of the house and sampling locations
- Description of corrective actions and their efficiency and efficacy

3. HEALTH ADVISORY ON INDOOR PETROLEUM VAPORS

Kerosene, unleaded gasoline, and fuel oils or home-heating oils are petroleum products. They are each made up of mixtures of many different kinds of chemicals referred to as hydrocarbons. Some of these hydrocarbons evaporate easily and are released into the air as petroleum vapors. Petroleum vapors have strong odors associated with them. Other petroleum chemicals do not evaporate into the air as easily, but may still smell if they are in an enclosed space like a basement.

People who live near an area where petroleum has been spilled may come in contact with petroleum if it moves into groundwater used for household purposes or when petroleum vapors have entered the soil and then move into basements of nearby buildings. If there is a petroleum spill in your basement, or there are strong odors that seem to be due to petroleum, it is best to leave the basement or the room(s) where the odor is strongest.

How can an unleaded gasoline spill affect my health?

Health effects may occur from breathing unleaded gasoline vapors in the air. Many of the harmful effects seen following exposure to unleaded gasoline are due to the individual chemicals in the gasoline mixture. The kinds of health effects that may occur depend upon the amount of unleaded gasoline that has spilled, and the length of time the spill has been present. If unleaded gasoline was recently spilled and you have been breathing concentrated gasoline vapors in indoor air, which is where the highest levels of gasoline vapors are expected, you may begin to feel dizzy, nauseated or drowsy and you may develop a headache. At much higher concentrations, more serious health effects, such as coma or potentially even death, may occur.

What are the long-term effects that may result from being exposed to an unleaded gasoline spill?

The possibility of long-term health effects from breathing unleaded gasoline vapors depends upon the amount that has spilled and the length of time the spill has been present. There is little information regarding effects on developmental or reproductive effects in humans from breathing unleaded gasoline vapors, but some of the individual chemicals in the gasoline mixture are known to have reproductive or developmental effects. Scientists have not yet determined whether breathing unleaded gasoline vapors causes cancer in humans.

How can a kerosene spill affect my health?

Health effects may occur from breathing kerosene vapors in the air. The kinds of health effects that may occur depend upon the amount of kerosene that has spilled, and the length

of time the kerosene spill has been present. Breathing kerosene vapor for as short as one hour can make you nauseated, increase your blood pressure, or irritate your eyes. Breathing moderate amounts of kerosene may also slightly decrease your ability to smell. Breathing much higher concentrations of kerosene may cause headaches and poor coordination.

What are the long-term effects that may result from being exposed to a kerosene spill?

Kerosene has not yet been evaluated for its ability to cause cancer. It is not known whether kerosene can cause birth defects or affect reproduction.

How can a home heating oil (fuel oil # 2) spill affect my health?

Health effects may occur from breathing home heating oil vapors in the air. The kinds of health effects that may occur depend upon the amount of home heating oil that has spilled, and the length of time the oil spill has been present. Inhalation of number 2 fuel oil vapors may make you nauseated or dizzy. It may also give you a headache or make it difficult for you to concentrate.

What are the long-term effects that may result from being exposed to a home heating oil (number 2 fuel oil) spill?

The possibility of long-term health effects from breathing home heating oil vapors depends upon the amount that has spilled and the length of time the spill has been present. Breathing number 2 fuel oil vapors for a long time may cause you to be tired or anxious or to have mood swings. There is some indication that number 2 fuel oil might be associated with reproductive or developmental effects, but only limited information are available. It is not known whether breathing home heating oil vapors causes cancer in humans.

How do I know if my health is being affected by the petroleum (fuel oil/kerosene/gasoline) spill?

If you are experiencing any of the health effects that are described above, then your health may be affected by the petroleum spill. Elderly people, children, and people who are chronically ill may be at greater risk for health effects associated with petroleum products as compared to healthy adults.

What should I do if I am experiencing health effects from a petroleum spill?

It is important to leave any area where strong odors from petroleum vapors are present. Seek fresh air either outside or indoors by opening windows and/or doors. Opening windows in the basement should help to reduce strong odors caused by petroleum vapors.

If you continue to experience health effects associated with petroleum vapors, you should seek medical advice.

Do lingering petroleum vapor odors have health effects associated with them?

The nose is very sensitive to extremely low levels of petroleum products. Based on the information available, it is possible that odors may linger without any health effects. These odors are called nuisance odors since they do not appear to cause any health effects, but are unpleasant to smell.

What are Maine DEP's action levels?

Air concentrations in excess of the *acute action levels* may warrant evacuation in order to protect against health effects resulting from short-term inhalation exposure. Air concentrations at or below the *acute action level* and above the *subchronic action levels* are protective for exposure durations ranging from 14 days to one year. Air concentrations at or below the subchronic action level and above the chronic action level are protective for exposure durations ranging from one year to a lifetime and are suitable for re-occupying a home. The DEP's criteria for closing involvement with air an quality problem is when all indicator compounds are stable at or below chronic action levels.

Where may I obtain more information?

If you have additional health related questions, call (207) 287-5189 to contact Doctor Andrew Smith, Director of the Environmental Toxicology Program at the Bureau of Health of the Department of Human Services. To report a petroleum release or request guidance for cleaning up spills, contact the Department of Environmental Protection, Bureau of Remediation, Division of Response Services at (800) 482-0777. If you want assistance in testing your indoor air quality, consult your local telephone directory for consultants who provide testing services.

APPENDIX A – UPDATES AND REVISIONS TO FIELD GUIDELINE SINCE PUBLICATION OF 10/98 GUIDELINE

Authority Initials	Revision	Description of Change	Location	Date
P.M.E.	001	Estimate risk associated with benzene background concentration –see below.	Appendix A	8/99
P.M.E.	002	Upate subchronic action level for napthalene – see below.	Appendix A	8/99
P.M.E.	003	DEP internal toxicology review	Appendix A	3/00
P.M.E.	004	1st Draft issue of Field Guideline		3/00
P.M.E.	005	Bureau adopted issue of Field Guideline		6/00

Revision 001

The Chronic Action Level for benzene is 3 ppb (10 ug/m^3) and is based upon the 50th per centile of background concentrations found in several residential indoor air studies (see 10/98 Guideline). 3 ppb is also the USEPA's provisional RfC for benzene which is derived to protect against non cancer adverse health effects (NCEA–S-0455, dated September, 1998).

The incremental lifetime carcinogenic risk associated with the 3 ppb action level ranges between 1 in 47,000 and 1 in 13,000. This is based upon U.S. EPA IRIS Substance file – Benzene; CASRN 71-43-2, dated 10/16/98 which estimates the incremental increase in the lifetime carcinogenic risk of an individual who is exposed to 1 ug/m^3 benzene in air (air unit risk) at a range between 2.2 x 10^{-6} to 7.8 x 10^{-6}. Disregarding background and using a 1x10^{-5} lifetime incremental cancer risk as established by DEP/DHS, the chronic action level would fall in the range of 1.3 to 4.5 ug/m^3 or 0.4 to 1.3 ppb.

Revision 002

The Chronic Action Level for naphthalene is 2 ppb (10 ug/m^3) and is derived in the 10/98 Guideline. Since publication of the 10/98 Guideline, the U.S. EPA has developed an RfC of 3 ug/m^3 or 0.6 ppb to protect against non cancer adverse health effects (U.S. EPA IRIS Substance file – Naphthalene; CASRN-91-20-3, dated 9/17/98). The 10/98 Guideline recommends adopting the RfC as the chronic action level. However; the results from the Trial Study conducted during the 1997/1998 winter indicate that the naphthalene RfC was not achieved at more than 50% of the investigated homes. For reasons of practicality, uncertainty on background concentrations for Maine residences, and its proximity to detection limits, the RfC for naphthalene will not be adopted at this time.

An inhalation unit risk estimate for naphthalene was not derived because of the weakness of the evidence (observations of predominant benign respiratory tumors in mice at high dose only) that naphthalene may be carcinogenic in humans.

Based upon the RfC and the convention used in the 10/98 Guideline, the Subchronic Action Level for naphthalene is reduced from the 20 ppb in the 10/98 Guideline to 6 ppb.

Revision 003

Memo

To: Peter M. Eremita, MEDEP, Southern Maine Regional Office

From: Catherine Zeeman, Ph.D., Toxicologist

Date: March 30, 2000

Re: October 1998 Guideline for Protecting Residents from Inhalation Exposure to Petroleum Vapors

Following, are comments on the use of guidance presented in the October 1998 document entitled "Guidelines for protecting residents from inhalation exposure to petroleum vapors." The guidance, developed for the Maine Department of Environmental Protection (DEP) by Menzie-Cura and Associates, is to help DEP staff evaluate impacts of petroleum vapors in residential air following gasoline, kerosene or fuel oil spills.

The guidance offers an indicator compound approach for evaluating potential health risks posed by exposure to fuel vapors. This approach is an alternative for evaluating risks posed by whole mixtures, which can be difficult to quantify because the composition will vary from one case to the next. The indicator compound approach focuses on individual substances that can be measured, and for which there are data to quantify toxicity. Each indicator compound represents a fraction of the compounds typically present in petroleum mixtures. It is assumed that action levels designed to protect against adverse effects from exposure to key constituents of the mixture (i.e., the indicator compounds) will also protect against adverse effects from exposure to the entire mixture. Confidence that such is the case depends on how the action levels were derived and how they are used. Comments on both aspects are provided below.

Derivation and Interpretation of Action Levels for Indicator Compounds

1. The approach and assumptions used to derive action levels for indicator compounds are compatible with risk assessment guidance developed by the Maine DEP and Department of Human Services (MEDEP/DHS, 1994[1]), and consistent with guidance developed by the U. S. Environmental Protection Agency (USEPA) for

[1] MEDEP/DHS. 1994. Guidance manual for human health risk assessments at hazardous substances sites. State of Maine Department of Environmental Protection and Department of Human Services, Augusta, Maine.

deriving inhalation reference concentrations (USEPA, 1994[2]). Both cancer and non-cancer health risk-based action levels were considered. Out of necessity, at least one action level is based on background concentrations.

a) Action levels based on cancer risk.

Cancer risk was evaluated for benzene only. Benzene is the only constituent of un-combusted gasoline, kerosene or fuel oil vapors currently classified by the USEPA as a known (Class A) or probable (Class B1 and Class B2) human carcinogen. Action levels based on cancer risk are intended to insure that exposure to benzene from a fuel spill will not increase an individual's lifetime risk of cancer by more than one per one hundred thousand (1/100,000). A cancer risk-based action level is for continuous exposure (24 hours / day, 7 days / week) over 70 years. The estimated risk will be proportionately lower for exposures that are less frequent or of shorter duration.

b) Action levels based on non-cancer effects.

Action levels based on non-cancer effects are considered thresholds below which no adverse effects are expected to result from continuous exposures of specific duration.

- No adverse non-cancer health effects are expected to result from exposures lasting less than 14 days to indicator compounds with concentrations at or below the acute action levels (see comment 5).

- No adverse non-cancer health effects are expected to result from exposures lasting up to one year to indicator compounds with concentrations at or below subchronic action levels (see comment 5).

- No adverse non-cancer health effects are expected to result from exposures lasting up to a lifetime to indicator compounds (except benzene and possibly naphthalene) with concentrations at or below chronic action levels (see comment 5).

[2] U.S. Environmental Protection Agency (USEPA). 1994. Methods for derivation of inhalation reference concentrations and application of inhalation dosimetry. EPA/600/8-90/066F. USEPA, Office of Research and Development, Washington, DC.

c) Action levels based on background.

Out of necessity, the chronic action level for benzene is based on the background concentration, which is greater than what the risk-based action levels would be. Exposure for one year or more to benzene at the background concentration may cause adverse non-cancer health effects in sensitive individuals. A lifetime of exposure to benzene at the background concentration may increase an individual's lifetime risk of cancer by more than 1/100,000.

The new risk-based chronic action level for naphthalene (comment 2) may be below background concentrations. However, data on naphthalene concentrations in residential air are very limited (ATSDR, 1995[3]). The feasibility of achieving the risk-based chronic action level for naphthalene will require further study (comment 2). Until an appropriate value for background is identified, the ability to achieve the risk-based concentration will have to be evaluated on a case-by-case basis. Exposure for one year or more to naphthalene at concentrations greater than the risk-based action level may cause adverse non-cancer health effects in sensitive individuals.

2. The chronic action level for naphthalene is currently a Minimum Risk Level (MRL) developed by the Agency for Toxic Substances and Disease Registry (ATSDR). In September 1998, the USEPA added a verified chronic reference concentration (RfC) for naphthalene to the Integrated Risk Information System (IRIS) database. Because verified RfCs are benchmarks that have undergone extensive peer review, they are preferred over interim values such as MRLs. The chronic RfC for naphthalene (3.0 $\mu g/M^3$ or 0.6 parts per billion) should be adopted as the chronic action level. These risk-based values may be below background concentrations. Studies reporting background concentrations for naphthalene in indoor air are few. Studies reviewed by the ATSDR (1995) report background concentrations for residential air that range from approximately 0.86 $\mu g/M^3$ (0.16 parts per billion) to 32 $\mu g/M^3$ (6.0 part per billion). Using the same data, Menzie-Cura and Associates identified a median background concentration of 0.4 $\mu g/M^3$ (2.0 parts per billion). Naphthalene concentrations tend to be higher in homes with smokers, where mothballs are in use, and in homes near heavily trafficked areas. It appears that risk-based action levels may be achievable in homes lacking other significant sources. However, given the uncertainty about what constitutes background, attainability of the risk-based action level will have to be evaluated on a case-by-case basis.

[3] Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for naphthalene (update). ATSDR, U.S. Department Of Health and Human Services, Atlanta, Georgia.

The subchronic action level for naphthalene is currently the chronic action level times ten. The subchronic action level should be changed to 30.0 μg/M^3 or 6.0 parts per billion to reflect changes in the chronic action level.

Using Action Levels for Indicator Compounds

3. As derived, risk-based action levels for indicator compounds will protect humans, including sensitive members of the population, against adverse effects from exposure to those substances. The background-based chronic action levels for benzene, and perhaps naphthalene, are considered as protective as is feasible.

4. Ultimately, action levels for indicator compounds will be used to evaluate potential risks posed by exposure to the total mixture of petroleum vapors (tVPH). To do so, action levels for indicator compounds should be compared to concentrations of the hydrocarbon fractions (classes) they represent. Ideally, concentrations of the fractions would be measured in air samples from each spill. Alternatively, concentrations of the fractions can be estimated using the measured concentration of tVPH and general knowledge of the relative contribution each fraction makes to the total for a particular source material (i.e., gasoline, kerosene or fuel oil). Unfortunately, analytical methods needed to support the first approach on an affordable and routine basis are not currently available. The ability to apply the second approach is hindered by a lack of general information on the composition of vapors produced by specific source materials. One of the two approaches should be adopted once the information / analytical method that is needed becomes available.

   The method currently in use for evaluating risks is to compare action levels for indicator compounds to measured concentrations of those substances only. While it may be all that is feasible at this time, this approach is the least desirable for evaluating risks posed by tVPH. The approach is a start and remediating to action levels for the indicator compounds will likely reduce risks posed by the entire mixture. However, confidence in conclusions about risks posed by tVPH will remain low due to considerable uncertainty about the composition of the mixtures that are present after spills.

5. Measured concentrations of indicator compounds should be evaluated collectively to help compensate for uncertainty about the composition and potential toxicity of the entire mixture. The simplest approach is to sum the ratios of measured concentrations to respective action levels[4] ($R_{chronic}$, $R_{subchronic}$ and R_{acute}). For

[4] The ratios should not be confused with hazard indices or hazard quotients (HIs or HQs) commonly used in risk assessment, because not all the action levels are risk-based.

example, whether measured concentrations of indicator compounds might collectively exceed chronic action levels can be determined as follows:

$$\Sigma R_{Ch} = (C_B/Ch\text{-}AL_B) + (C_E/Ch\text{-}AL_E) + (C_N/Ch\text{-}AL_N) + (C_T/Ch\text{-}AL_T) + (C_X/Ch\text{-}AL_X)$$

$$+ (C_{Hex}/Ch\text{-}AL_{Hex}) + (C_{Non}/Ch\text{-}AL_{Non})$$

Where:

ΣR_{Ch} = The cumulative ratio for chronic action levels

C_B = Measured concentration of benzene (ethylbenzene, napththalene, toluene, xylene, hexane and nonane), and

$Ch\text{-}AL_B$ = Chronic action level for benzene (ethylbenzene, napththalene, toluene, xylene, hexane, and nonane).

Cumulative ratios are also used for acute exposures (ΣR_A) and subchronic exposures (ΣR_{SCh}) using acute and subchronic action levels, respectively.

If $\Sigma R_A > 1.0$, then actions to reduce acute exposure (up to 14 days) are indicated;

If $\Sigma R_{SCh} > 1.0$, then actions to reduce subchronic exposures (up to 1 year) are indicated; and,

If $\Sigma R_{Ch} > 1.0$, then actions to reduce chronic exposure (over 1 year) are indicated.

In summary, the guidance proposes an indicator compound approach for evaluating human health risks posed by exposure to fuel vapors in residential air. The method used to derive action levels for indicator compounds is inherently conservative

(protective). Consequently, the risk-based action levels are considered protective of human health. The action levels reflect what is currently known about the indicator compounds. It would be prudent to re-evaluate the action levels periodically, as more information on toxicity and / or background concentrations of the compounds becomes available.

Using the action levels will protect against adverse effects from exposure to the indicator compounds. It is likely that using action levels for indicator compounds will also help reduce risks posed by exposure to all the other volatile petroleum compounds that may be present after a fuel spill. Confidence in the latter conclusion is low due to uncertainty about the composition of the mixtures that may be present. To compensate for this uncertainty, it is recommended that the indicator compounds be evaluated collectively (as a mixture). It is also recommended that an assessment approach based on specific knowledge of the total hydrocarbon mixture be adopted once the information and / or analytical methods that are needed become available.

Feel free to contact me (Katie Zeeman) at 287-7822 if you have any questions about comments or recommendations offered in this memorandum.

APPENDIX B - Forms Used in Conducting Residential Investigations

State of Maine Department Of Environmental Protection

RESIDENTIAL INVESTIGATION DATA FORM

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SECTION 1: BACKGROUND INFORMATION

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Note: Complete Sections 1 And 2 Upon Initial Investigation
Complete Section 2 During Subsequent Investigations

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PART 1: RESIDENT INFORMATION

Spill Number: _____

Resident's Name: _____

Address: _____

_____

Telephone number: _____

OHMS responding to spill:_____
Staffperson completing form:_____
Date information collected:_____

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PART 2: CHARACTERIZE PETROLEUM SPILL

1. What type of petroleum product was spilled?
   ☐ fuel oil ☐ gas ☐ kerosene ☐ other _____

2. How much product was released/recovered (gallons)? _____ /_____
3. How, When and Where did the petroleum spill occur and describe impacts?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

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PART 3: GENERAL HOUSEHOLD INFORMATION

4. Which best describes the home? (Check all that apply.)
   _____ one-family house detached from other houses
   _____ one-family house attached to one or more houses
   _____ building for 2 or 3 families_____ building for 5 or more families
   _____ first floor_____ second floor _____ third floor

5. Is there an attached garage? ☐ YES ☐ NO

6. Which of the following does the home have?
   ____ basement ____ basement and crawlspace
   ____ crawlspace ____ other(specify)
   ____ slab foundation ____ don't know

7. Does the foundation/slab have a drainage system?. If YES, please describe.

8. Approximately when was the home built? ____ 1939 or earlier ____ 1940-1949 ____ 1950-1959 ____ 1960-1969____ 1970-1979____ 1980-1985 ____1986 or later ____ don't know

9. Has the home undergone any recent (previous year) renovations? IF YES, please describe.

10. Household demographics (number of residents, age, sex) and existing illnesses

11. Describe yard area around the home, i.e. forested, lawn, garden, pavement:

12. Describe the amount of vehicle traffic passing in front of or near the home?
   ____ heavy highway traffic____ quiet, paved street____ busy, paved street
   ____ dirt road____ moderately-busy, paved street

13. Are there any potential outdoor sources of petroleum (e.g. gas stations, parking lots, marinas) near the home (within about a mile)? IF YES, what types of sources (filling stations, bulk plants, parking lots, heavy traffic, …?)

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PART 4: HEATING/AIR CONDITIONING/AIR CLEANING?

14. How is the home heated? (Mark all that apply)
   ____ Electricity ____ Natural gas ____ Kerosene____ Propane gas
   ____ Solar ____ Oil ____ Coal ____ Wood (fireplace, wood stove) ____Other

15. Is the home heated by any type of furnace system? (Mark all that apply.)
    ____ No
    ____ Steam or hot water furnace system (radiators or baseboards)
    ____ Central warm air furnace with ducts to rooms
    ____ Vented floor, wall or pipeless furnace
    ____ Unvented floor, wall or pipeless furnace

16. Identify any secondary heating systems used in the home, including frequency of use.
    ____ wood stove____ space heaters (specify electric, kerosene, oil)
    ____ fireplace____ coal

17. Do residents use a gas cooking stove? _____

18. Do residents use any air cleaning devices? Do not count furnace filters. (Mark all that apply.)
    ____ None ____ Charcoal____ Filter____ Electrostatic precipitator
    ____ Ion generator____ Other (specify) _____

19. Does the home have any air conditioning? ☐ YES ☐ NO
    IF NO, skip to question # 20.

    Which rooms have air-conditioning?
    ____central ____ living or family room____ bedroom____ other rooms (specify)

    What type of air conditioning?
    ____ Refrigerative ____ Evaporative ____ Attic Fan ____ Don't know

    Does the air conditioner recirculate indoor air, or bring in fresh air from outside, or both?
    ____ recirculates indoor air____ brings in outside air____ Don't know

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PART 5: SMOKING

20. Does anyone living at this address smoke cigarettes, pipes or cigars? ☐ YES ☐ NO
    IF YES, what is the total number of smokers in your household?____
21. About how many cigarettes are smoked on average per day inside the home?
    ____ fewer than 10 ____ 10 to 14 ____ 1 pack ____ 1 1/2 packs ___ 2 packs
    ____ 2 1/2 packs ____ 3 packs ____ more than 3 packs
22. Not counting people living in the household, does anyone smoke cigarettes within the home? (Include regular visitors such as grandparents or babysitters.) ☐ YES ☐ NO
    IF YES, counting only these other smokers, about how many cigarettes are smoked per day inside the home?
    ____ fewer than 10 ____ 10 to 14 ____ 1 pack ____ 1 1/2 packs ___ 2 packs
    ____ 2 1/2 packs ____ 3 packs ____ more than 3 packs
23. Does anyone in the household smoke pipes or cigars?
    ____ pipes ____ cigars ____ neither

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Part 6 DATE/DECRIPTION OF INVESTIGATIONS AND CORRECTIVE ACTIONS TO DATE

DATE	DESCRIPTION

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SECTION 2: INDOOR AIR ASSESSMENT

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PART 7: GENERAL INFORMATION

Investigator:_____
Spill Number:_____
Date of investigation/interview:_____

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PART 8: HEALTH EFFECTS ASSESSMENT

1. Are residents complaining of any health effects that they attribute to the spill? ☐ YES ☐ NO

IF YES, describe symptoms. Symptoms associated with petroleum exposure may include runny nose, eye irritation, nausea, confusion, diarrhea, stomach cramps, coughing, dizziness, throat irritation, drowsiness, headache, difficulty concentrating, poor coordination.

_____
_____
_____

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PART 9: LABORATORY SAMPLE INFORMATION

2. Maintain and attach copy of Laboratory Chain of Custody with Resident Name, Sampler Name, Spill Number, Sample #, Date and Time of Sample Collection, Sample Duration, Sample Equipment, Turnaround Time, Analysis Method, Analytes….

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PART 10: FIELD SCREENING SAMPLE INFORMATION

3. Was there an odor present in the home at the time of sampling? If yes, describe (mild/ moderate/severe, fresh/weathered, K1/#2/gasoline).

4. Field Screening w/ a _____ PID , calibrated with DEP Set Point of _____ for a _____ ppm isobutylene standard.

Date	Time	PPM	Location (correspond with a particular lab sample?)

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Part 11: OTHER SOURCES PRESENT /HOUSEHOLD ACTIVITIES OCCURRING WHILE THE INDOOR AIR SAMPLERS WERE OPERATING THAT MAY AFFECT RESULTS

Potential Indoor Sources	Present? Yes/No	Location (i.e. room)
Open[1] containers of paint and paint thinners		
Open containers of any petroleum products		
Cleaning or furniture refinishing solvents		
Mothballs		
Oil tanks		
Wood stoves		

5. Were any cigarettes, cigars or pipes smoked in the home? If YES, how many cigarettes or cigars were smoked or for how long was the pipe smoked?

6. Did residents use any pesticides, household cleaning products, or other household chemical products? If YES, what type and where?

7. Did residents use cooking oils and/or sprays? If YES, what type and where?

8. Were any windows or doors open (other than normal opening and closing of doors as residents enter and leave the home)?. If YES, identify the rooms in which windows or doors were open and for how long:

9. Was the home heated in any way? If YES, what type of heating source was used (e.g. central gas, oil or electric heater, fireplace, woodstove, space heaters) and for how long?

10. Did residents do any carpentry work or other hobbies? If YES, please describe these activities

11. Did residents perform any car maintenance in an attached garage? If YES, please describe maintenance work

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Part 12: WEATHER CONDITIONS DURING INDOOR AIR SAMPLING

12. Average outdoor air temperature (in degrees Celsius) _____

13. Prevailing wind direction W SW NW E SE NE N S

14. Average wind speed (km/hr) _____

15. Average relative humidity (%) _____

16. Average barometric pressure (inches of Hg) _____

17. Describe general weather conditions (e.g. sunny, cloudy, precipitation)

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Part 13 PHOTO LOG / SKETCH OF FLOOR PLANS & SAMPLE LOCATIONS

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PART 14: INDOOR AIR SAMPLE COLLECTION PROTOCOL

- Place samplers where they will provide a representative sample of indoor air breathed by residents.
- Perform sampling in a room that is used regularly, such as a living room, den, or playroom.
- Avoid bedrooms, kitchens, and laundry rooms where use of personal products and other chemical products may interfere with sampling.
- Perform "living area" sampling at the lowest level of the house suitable for occupancy.
- Place indoor samplers on stands approximately 1 meter above the floor away from drafts (e.g., vents, open doors and windows, air conditioners, fans), high heat (heaters and heating vents), high humidity, exterior walls, and other obstructions to air flow.
- Samplers should be placed on wooden stands or a piece of furniture in the central part of the room.
- All sampling equipment should be placed away from family traffic patterns and out of reach of pets and children.
- Samplers should not be placed close to attached garages, ash trays, or other possible petroleum constituent sources that might provide results that do not reflect contamination related to the petroleum spill.
- Document PID readings collected at the locations and instant SUMMA® canisters are activated.
- Sketch sampling locations.
- Advise residents to close windows and keep outside doors closed as much as possible during sampling, except for normal entry and exiting.
- Advise residents to not operate fans or other ventilation equipment.
- Advise residents to only operate air conditioning units that recirculate interior air.
- Advise residents to remove or tightly seal obvious indoor sources of petroleum constituents during indoor air sampling; such as, fuels, paints, cleaning solvents, and mothballs.
- Advise residents to avoid activities (smoking, painting, cleaning, cooking) that may influence indoor air sampling results.

Quality Control/Quality Assurance

- Follow the manufacturer's guidelines for use of sampling equipment and holding times.
- Collect duplicate samples for at least 5% of houses investigated.
- Analyze samples as soon as possible after sampling.